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Postpartum Anxiety and Infant-Feeding Outcomes: A Systematic Review

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Abstract

There is increasing evidence for the impact of postpartum anxiety (PPA) on maternal and infant health outcomes. Despite evidence linking suboptimal infant-feeding outcomes with other indices of maternal mental health, the relationship between PPA and infant-feeding has not yet been reviewed. A systematic review with narrative synthesis was conducted to examine the relationship between PPA and infant-feeding outcomes. Electronic searches were performed using specific keywords (e.g. 'postnatal anxiet*'; "breastfeed*"). A hand search of selected journals and reference lists of included articles was then conducted. All studies were considered that provided information related to PPA and infant feeding outcomes. 102 studies were identified, of which 33 were eligible. Two authors independently extracted data including study design, participants, and results. Results indicated that women with symptoms of PPA are less likely to breastfeed exclusively, and more likely to terminate breastfeeding earlier. Some evidence also suggests that those experiencing PPA are less likely to initiate breastfeeding and more likely to supplement with formula in the hospital. In those that do breastfeed, PPA reduces self-efficacy, increases breastfeeding difficulties, and may negatively affect breastfeeding behaviours and breast milk composition. Heterogeneous outcomes and methodological limitations somewhat limit the comparability of findings. However, in combination with a review linking depression with similar negative infant-feeding sequelae, the findings provide evidence for the impact of negative postpartum mood on breastfeeding. Additional support for breastfeeding mothers with PPA is warranted.

Introduction

Childbirth is a major life event and the abrupt change in life roles and responsibilities in the postpartum period represents a time of risk for the development of anxiety.[1] Prevalence studies of postpartum anxiety (PPA) reveal estimates of its incidence ranging from 3% to 43%, with evidence that it may occur independently and at a higher rate than postpartum depression (PPD).[1–4] However, PPA has received limited attention despite evidence linking anxiety with a range of adverse infant health outcomes.[1,2,4] Even at subclinical levels and independent of comorbidity of depression, PPA has been linked to insecure attachment behaviours,[5] delayed cognitive development [6], negative temperament,[7] and low social engagement[8] - all relevant outcomes given their relationship with infant feeding.[9–11]

Maternal symptoms of PPA have also been independently implicated in infant feeding outcomes. These include low self-efficacy in the parenting role,[12] diminished maternal reactivity/sensitivity, and decreased coping capability.[13] There is strong evidence that low self-efficacy and reduced confidence are key variables influencing breastfeeding initiation and duration.[14–16] Associations between maternal sensitivity and breastfeeding initiation, duration and exclusivity have also been consistently identified.[17–19]

The neurobiological literature provides two fundamental associations between PPA and lactation Firstly, PPA may negatively influence breastfeeding and the composition of breast milk through physiological stress responses.[20–22] General (i.e. trait) anxiety disrupts the release of oxytocin and prolactin; hormones which promote the milk ejection reflex.[4,20,21] Frequent inhibition of this reflex may cause a physiological reduction in breast milk production.[20,23] Furthermore, acute emotional stress (i.e. state anxiety) is associated with elevated cortisol and glucose levels. These hormones have been implicated in delaying breast fullness and decreasing milk volume in the immediate postpartum.[23] The second position

provides evidence that lactation results in endocrinological alterations that buffer symptoms of anxiety.[4] This may simply be through anxiolytic contact with infants,[4] or the physical act of breastfeeding.[24] Animal models have shown hormones produced during lactation can moderate environmental stimuli and subsequent stress responses.[25,26] Despite some unclear results in lactating women,[24,25,27,28] it is theorised that similar processes occur in humans.[25]

Finally, there is evidence linking suboptimal infant feeding outcomes with other indices of maternal mental health. A systematic review examining the relationship between postpartum depression and infant feeding outcomes found that women with depressive symptoms are at an increased risk of experiencing reduced breastfeeding initiation, duration and self-efficacy.[29] A similar review found that women with high levels of prenatal anxiety were more likely to express intentions to formula feed and may be less likely to exclusively breastfeed.[30] Given high rates of sequential and concurrent comorbidity between PPA and other indices of maternal mental health, and a lack of studies controlling for these key confounds,[30] it is conceivable that PPA may also undermine recommended feeding practices via these processes.

While there is increasingly robust evidence to suggest a relationship between PPA and infant feeding outcomes, no such summary of the literature has been completed. As such, this research aims to provide a comprehensive systematic review of all existing studies which examine the relationship between PPA and infant feeding outcomes. Similar to other reviews of this nature,[29,30] a narrative synthesis will be applied to account for the heterogeneity in methodologies, measures, and analyses found in the field. Given the well-established benefits of recommended infant feeding practices, and the substantial lack of uptake to these recommendations globally,[31–34] clarifying this relationship is vital for all those working towards improving maternal and infant health.

Methods

This systematic review of the literature used a narrative synthesis methodology. Included studies were initially grouped according to infant feeding outcome (sub-group). Each study within a sub-group was then described in a commentary reporting on study characteristics including design, sample, measures, results, and methodological issues. Differences and similarities among study results were then synthesised to draw conclusions within and between sub-groups.

Eligibility Criteria

Published and unpublished studies were eligible if they collected data relating to current or previous infant feeding attitudes, behaviour or biological sequelae (i.e. breast milk composition), and examined anxiety in the postpartum. Given high variability in breastfeeding definitions, for the purpose of this review, breastfeeding behaviour was defined as any current or previous breastfeeding activity at any intensity (i.e. exclusive, any). The operational definition of PPA utilised was any sub-clinical, self-reported symptoms or clinical diagnosis of anxiety occurring during the first year postpartum. This liberal time interval was allowed to account for varying methodologies in the literature. Studies which examined women with anxiety symptoms (sub-clinical or clinical) identified pre-pregnancy or during pregnancy were not deemed eligible. Other mental health conditions occurring during pregnancy or the postpartum (i.e. prenatal anxiety, prenatal or postnatal depression, postpartum blues, and puerperal psychosis) were also ineligible. However, due to recognised high comorbidity rates with postnatal depression, research that focused on postnatal depression were examined if the measures used contain an anxiety subscale with analyses for PPA reported separately. Prospective designs that examined prenatal anxiety were also examined if PPA was subsequently measured. Studies of mothers with premature (<37

weeks) or very low birth weight (VLBW; <1500g) infants, or those in Special Care Baby Units or Neonatal Intensive Care Units at the time of study were not deemed eligible. Psychological distress is common in these populations[35–37] and inclusion was expected to confound results. Mothers of infants with specific medical problems known to affect feeding (e.g. cerebral palsy, cleft lip or palate, gastrointestinal disorders, severe allergies) were also excluded due to the high risk of confounding. Table 1 provides a summary of inclusion/exclusion criteria. No language restrictions were placed upon eligibility of studies. Two studies [38,39] required translation from international academics. The review protocol can be obtained from the authors.

Information Sources

Scoping searches were initially conducted by a perinatal researcher and psychology librarian. The search strategy involved systematically reviewing both published and unpublished articles and theses targeting academic research, conference proceedings, and local and central government studies. The information sources were broad to ensure that a comprehensive range of studies were assessed for their relevance. The initial search strategy was limited to the inception year of each database to August 2015. Databases searched were: Medline (1966-2014), Global Health (1910-2014), Cumulative Index to Nursing and Allied Health Literature (CINAHL) (1982-2014), PsycInfo (1887-2014), PsycArticles (varies by title), Proquest (varies by database), AMED (1985-2014), Cochrane Library (varies by database), Scopus (1823-current), and Google Scholar (varies by title). Key words used in various combinations included “postpartum anxiety,” “postnatal anxiety,” “maternal anxiety,” “breastfeeding,” “infant feeding,” “formula feeding,” and “bottle feeding”. Boolean operators were applied to blend the key words and truncation was used to retrieve variants of each key word. Controlled vocabulary (MeSH) was applied when searching the Medline

database. An example of a full electronic search strategy can be found in Appendix 1. Tables of contents for key journals were hand searched from 2012 to 2015. A manual search of reference lists of included articles and relevant reviews was undertaken alongside correspondence to experts in the field to identify any data sources not yet found via previous methods.

Study Selection

A three-stage screening protocol was followed. Titles were assessed and any articles that were evidently unsuitable were excluded at this preliminary stage. Abstracts were then screened and excluded where appropriate. Finally, the full text of each eligible article was read thoroughly by two authors (VF and JH) to determine inclusion in the synthesis.

Data Extraction

Two review authors (VF and JH) independently extracted data from the included studies. Any inconsistencies were resolved by discussion or, where necessary, KB was consulted. For each study, data extracted included study design, participants (sample size and characteristics), measures taken, results, and pertinent methodological details. Where necessary, authors were contacted to identify/confirm any missing or ambiguous data. The Newcastle-Ottawa Quality Assessment Scale (NOS) was then applied independently to each included study by VF and JH to generate methodological discussion within and across studies. The NOS is quality assessment tool which detects risk of bias. It is recommended by the Cochrane Collaboration to examine the quality of observational studies in a systematic review.[40] A modified version of the NOS, previously applied in health research, was used for cross-sectional designs.[41]

Results

The search strategy identified 102 studies, of which 33 offered information specifically related to PPA and infant-feeding outcomes (Table 2). Some studies reported multiple outcomes (e.g. breastfeeding initiation and duration) yielding 45 different analyses. Studies included were published between 1959 and 2014 with sample sizes ranging from 32 to 186,452 (N = 194,402). Samples were derived from 11 countries (Australia, Barbados, Brazil, Canada, France, Germany, Italy, Japan, Turkey, United States, and the United Kingdom). Similar to other reviews in the area,[29,30] heterogeneity in measures, methods, and timing of outcome assessments meant a meta-analysis was not statistically feasible. Instead, data was narratively synthesised according to infant-feeding outcome: breastfeeding initiation; exclusive breastfeeding; any breastfeeding; breastfeeding attitudes; maternal/infant breastfeeding behaviour; and breast milk composition. Where multivariate analyses were conducted to adjust for confounds, they were given reporting precedence over bivariate analyses.

PPA and Breastfeeding Initiation

Nine studies examined the association between PPA and breastfeeding initiation.[42–50] Two, using diagnostic criteria, found a positive relationship.[42,43] In a dated US cross-sectional study,[42] primiparous (n=50) and multiparous (n=54) mothers who initiated breastfeeding were more likely to be categorised as "anxious" than "calm" pre-discharge by a trained psychiatrist. In an Australian population-based longitudinal cohort study,[43] mothers who did not initiate breastfeeding in the hospital (i.e. exclusively formula fed) were less likely to be admitted to hospital with an ICD-10 diagnosis of anxiety disorders in the first year postpartum (ARR: 0.6; 95% CI: 0.5, 0.9). However, formula feeding initiation in the hospital was associated with earlier hospital admission (41 days) in those that presented with such a diagnosis (n=585, $p<.05$).

Two studies found an inverse relationship between breastfeeding initiation and levels of PPA.[45,46] In a US study, 422 women completed the STAI-state scale pre- discharge.[45] Participants who initiated breastfeeding immediately after the birth had significantly lower anxiety scores than those who did not ($p<.05$). Similarly, a cross sectional UK survey of 508 women using a postpartum specific anxiety subscale found that mothers who initiated breastfeeding had significantly lower levels of anxiety ($p<.006$) than those who fed expressed breast milk or initiated formula feeding.[46] Interestingly, there was no difference between the latter two categories.

Two studies also found a positive association between PPA and pre-discharge formula supplementation.[44,45] In the study described above,[45] Britton found that mothers who supplemented with formula in the hospital had significantly higher pre-discharge state anxiety scores ($p<.005$). In a Canadian, cross-sectional study, using a representative sample of 564 women,[44] high maternal trait anxiety at two weeks postpartum was a positive predictor of supplementation in hospital (HR: 1.61, 95% CI: 1.01, 2.59). No such relationship was observed between state anxiety and supplementation.

Three studies found no relationship between PPA and breastfeeding initiation.[47,48,50] In a UK cohort study of 145 women, there was no significant difference in state or trait anxiety scores at one week or five months postpartum between those who had initiated breastfeeding and those who had not.[50] An Australian cohort study (n=159) found no significant difference in Duke Health Profile (anxiety subscale) scores at three months postpartum between those who initiated breastfeeding in the hospital and those who did not.[47] In a cross-sectional study of 36 primiparous US women, there were no difference in post-delivery state anxiety levels between breastfeeding initiators and non-initiators.[48] Finally, a Canadian cohort study examined PPA in 306 women using the HAM-A at 3 months and the STAI at three and six

months postpartum.[49] Due to an unusually high prevalence of breastfeeding initiation (94.2%), there was insufficient variance to assess differences.

PPA and Exclusive Breastfeeding

Eight studies assessed the relationship between PPA and exclusive breastfeeding.[24,45,49,51–55] Six found an inverse relationship between levels of PPA and exclusive breastfeeding using both cross-sectional,[24,54] and prospective cohort designs.[45,49,52,55]

In a Canadian cohort study of 306 women,[49] a single point increase in HAM-A scores at three months postpartum was associated with an 11% reduction in the odds of exclusive breastfeeding at 6 months (AOR: 0.89; 95% CI: 0.80, 0.99). However, results did not persist when measured with a different anxiety scale (STAI state and trait at three and six months postpartum) or when examining exclusive breastfeeding at three months. Another Canadian cohort study measured state and trait anxiety and exclusive breastfeeding status at one week and six months postpartum in a sample of 856 women.[52] Multivariate analyses revealed that high trait anxiety at one week postpartum was a significant risk factor for ceasing exclusive breastfeeding during the first six months postpartum (CPH: 1.43 95% CI: 1.18, 1.74). No associations were present for state anxiety at either time point or trait anxiety at six months.

In a US cohort study, state anxiety at hospital discharge and one month postpartum was measured in a sample of mothers who were breastfeeding at discharge (n=356).[45] Regression analyses revealed that women with higher state anxiety at discharge were less likely to practice exclusive breastfeeding at one month (AOR: 0.96; 95% CI: 0.93, 0.98). These results persisted for women with higher anxiety at one month postpartum (AOR: 0.97; 95% CI: 0.95, 0.99). In an Italian cohort study, primiparous women (n=101) with higher state anxiety levels in the immediate postpartum were less likely to exclusively breastfeed for

longer than three months (AOR: 0.93; 95% CI: 0.88, 0.98).[55] No such association was observed for trait anxiety levels.

In a cross-sectional study of 183 US mothers, lower POMS (anxiety subscale) scores were observed in participants who exclusively breastfed to 4-6 weeks when compared to exclusively formula feeding women and a non-postpartum control group, $F(2,166) = 3.88$, $p<.05$.[24] Post hoc analyses revealed that the difference lay between the exclusive breastfeeding and formula feeding groups ($p=.01$). In a similar cross-sectional study of 60 primiparous US women,[54] MAS (anxiety subscale) scores were significantly different among participants who exclusively breastfed, exclusive formula fed or combination fed $F(2,57) = 4.8$, $p<.01$. Exclusively breastfeeding mothers had lower mean anxiety, but no post-hoc analyses were conducted.

Two studies found no relationship between PPA and exclusive breastfeeding.[51,53] A Turkish cohort study of 60 mothers measured state and trait anxiety at one month postpartum and found no significant differences between levels of anxiety and exclusive breastfeeding status at four months postpartum.[51] A much larger Australian cohort study mailed the DASS-21 to 657 mothers in the first two weeks postpartum and followed up with a telephone interview at 26 weeks postpartum.[53] Anxiety subscale scores were not associated with exclusive breastfeeding status at 26 weeks.

PPA and Any Breastfeeding

14 studies examined the relationship between PPA and breastfeeding duration in any quantity. Of these, 10 found an inverse relationship.[1,38,45–47,49,50,56–58] Findings are synthesised into breastfeeding of less than or more than three months.

PPA and Any Breastfeeding Duration <3 months

In a cross-sectional study of 508 UK mothers,[46] those who were still breastfeeding in any quantity at both two weeks and six weeks postpartum had a reduction in anxiety (IPSQ subscale) when compared to formula feeding mothers and those who fed expressed breast milk (two weeks: F (1,472) = 6.63, *p*=.01; six weeks: F (1, 409) = 5.48, *p*=.02). In a US cohort study of 356 breastfeeding mothers, state anxiety at hospital discharge and one month postpartum was measured.[45] Regression analyses revealed that women with higher state anxiety at discharge and one month were more likely to have terminated breastfeeding in any quantity by one month (AOR: 1.07; 95% CI: 1.03, 1.12; AOR: 1.07; 95% CI: 1.03, 1.11) respectively. In a US cohort study of 60 primiparous women,[58] state anxiety post-delivery was significantly lower among mothers continuing predominant breastfeeding at four weeks postpartum when compared to those who choose to supplement more than 4oz formula per day (*p*=.04). No difference was found at two weeks postpartum. In a US cross sectional study of 145 primiparous women,[57] specific postpartum breastfeeding worry was negatively associated with the decision to continue predominant breastfeeding (< 1 formula feed per day) for six to eight weeks (β=-.12; *p*<.01). In a UK cohort study of 145 women,[50] state and trait anxiety at one week postpartum were predictive of breastfeeding discontinuation at two months *F* (2,28) = 3.99, *p*<.03. No associations were present at five months.

PPA and Any Breastfeeding >3 months

In a US cohort study of 204 primiparous mothers,[56] trait anxiety (but not state) pre-discharge scores were negatively associated with successful breastfeeding (combination of any breastfeeding and satisfaction with breastfeeding) at four months postpartum (r=-.29, *p*<.001). In a French cohort study of 247 mothers who initiated breastfeeding,[38] higher levels of state anxiety at discharge were associated with reduced odds of any breastfeeding continuation at six months postpartum (AOR: 1.18, 95% CI: 1.06, 1.32). In an Australian

cohort study of 159 women,[47] lower Duke Health Profile (anxiety subscale) scores at three months (but not six months) postpartum were associated with any breastfeeding continuation at six months postpartum (F = 3.61; 95% CI: 17.27, 25.73; *p*=.02). In a cohort study of 1123 US mothers,[1] a positive STAI state screen (score >40) during the maternity stay was associated with reduced breastfeeding duration in any quantity during the first six months postpartum (*p*=.003). In a Canadian cohort study of 306 mothers,[49] a single point increase in STAI (state and trait) scores at three months was associated with a 4% (AOR = 0.96; 95% CI: 0.92, 0.99) and 7% (AOR = 0.93; 95% CI: 0.86, 1.00) reduction in the odds of any breastfeeding at 12 months respectively. No differences were found for HAM-A scores at three months or STAI scores at six months.

Four studies found no relationship between PPA and any breastfeeding activity.[53,59–61] In an Australian cohort study of 365 women,[59] state anxiety at three months postpartum was not related to breastfeeding cessation at various postpartum time periods (< 2 weeks, 2-6 weeks, >6 weeks to 3 months, >3 months). Another Australian cohort study of 657 women measured PPA in the first two weeks postpartum using the DASS-21 (anxiety subscale) and found no association with any breastfeeding activity at 26 weeks.[53] A cross-sectional study of 55 US mothers found no difference in State-Trait Personality Inventory (anxiety subscale) scores between women providing any breast milk and those providing no breast milk in the first year postpartum.[60] Another cross-sectional study of 48 US mothers found that anxiety ratings after viewing emotive videotapes of their infants did not differ between breast and formula feeding mothers of infants aged between three and six months.[61]

PPA and Breastfeeding Attitudes

Four studies collected data relating to PPA and maternal attitudes to breastfeeding. In a US cohort study of 422 women,[45] state anxiety scores were negatively correlated with

breastfeeding confidence scores prior to hospital discharge (r = -.27, p<.001). Similarly, in a cross-sectional study of 522 Canadian mothers at one week postpartum,[62] state anxiety was one of eight variables predicting breastfeeding self-efficacy scores (β=-.15; p<.001). In two studies reporting data collected from the same Barbadian cohort,[63,64] high Zung Anxiety Scale scores at seven weeks postpartum were associated with negative feeding attitudes at seven weeks (the belief that breastfeeding is restrictive: r=.17; p<.05; and should be private: r=.17; p<.05),[63] and a lower preference for breastfeeding at three months postpartum (r=-.24; p<.05).[64]

PPA and Maternal/Infant Feeding Behaviours

Five studies examined the relationship between PPA and various maternal and infant-feeding behaviours.[39,50,65–67] Two assessed PPA in relation to infant-feeding difficulties.[50,67] In A UK cohort study of 145 women,[50] state and trait anxiety scores at one week and five months postpartum were collected alongside researcher-developed scales of feeding difficulties and physical problems with breastfeeding at five months. At one week postpartum, high trait anxiety was associated with food fussiness (t=3.35, p<.01), and at five months postpartum was associated with hungriness and demanding behaviour (t=2.53, p<.05). High state anxiety at five months postpartum was associated with infant reflux concerns (t=2.75; p<.01). State anxiety levels at one week postpartum and infant-feeding difficulties were not related. Anxiety (state, trait at both time points) and physical breastfeeding problems were also not associated. In a cross sectional study of 57 German women,[67] state and trait anxiety was measured alongside the Crying, Feeding and Sleeping Inventory when the infants were aged between two and five months old. State and trait anxiety were positively associated with the 13-item infant-feeding difficulty subscale (β = .41; p<.001; β = .48, p<.001) respectively.

Two studies examined the relationship between PPA and maternal breastfeeding behaviours.[39,66] In a Brazilian cohort study of 168 breastfeeding mothers,[39] state and trait anxiety were measured at 10 days postpartum, and state anxiety data collection was repeated at 30 days postpartum. No relationship was found between state or trait anxiety and milk production in the first month postpartum. In a US cross-sectional study of 50 breastfeeding mothers in the second week postpartum,[66] state anxiety was measured alongside scales examining latch quality, milk intake, sensitive positioning, frequency of touch, frequency of vocalisation and duration of feeding. Anxiety was positively associated with frequency of touch during a feeding session $F(1,49) = 5.67$, $p<.05$, $\eta 2 = .11$). No other associations were present.

Finally, a dated US cross-sectional study examined PPA in relation to infant satiety and formula consumption in a sample of 65 exclusively formula feeding women.[65] State anxiety was measured pre-feed and in-feed; trait anxiety was measured post-feed. Infants of slightly anxious mothers consumed more formula than those with extremely low anxiety ($t=2.05$, $p<.05$). Infant satiety analyses could not be performed.

PPA and Breast Milk Composition

Four studies examined the relationship between PPA and breast milk composition in samples of exclusively breastfeeding mothers.[22,68–70] In a US cross-sectional study,[68] 32 mothers completed state anxiety and POMS (anxiety subscale) measures between seven and eleven days postpartum. Milk samples were collected two hours post-feed to examine levels of cortisol and secretory immunoglobin (Sig A). No associations were found. In a similar cross sectional design, a larger sample of 101 Japanese mothers completed the STAI (state and trait) and POMS (anxiety subscale) at two weeks postpartum.[69] Breast milk Sig A levels were examined immediately after breastfeeding. Inverse correlations were found between

state, trait and POMS anxiety scores and levels of Sig A in milk samples (r=-.33, *p*=.004; r=-.43, *p<.001;* r=.33, *p*<.05). Another cross-sectional study of 42 Italian women collected STAI (state and trait) data alongside colostral milk beta-endorphin (β-EP) concentrations at four days postpartum.[22] In mothers that delivered vaginally (n=14), there was a significant negative correlation between state anxiety and colostral milk β-EP (r=-.40, *p*=.03). Finally, in a prospective case-control study, 64 Turkish women completed STAI (state and trait) measures.[70] Cases were defined as having elevated breast milk sodium levels with associated hypernatraemic dehydration (n=21). These mothers had significantly higher state (but not trait) anxiety scores when compared to controls (*p*=.04).

Discussion

The aim of this review was to examine the relationship between PPA and infant-feeding outcomes. Of the 45 included analyses from 33 studies, 9 (20%) analyses from 8 (24%) studies reported no relationship between these variables.[47,48,50,51,53,59–61] Among these, two were conducted in the 1980's,[48,61] four with small sample sizes may have lacked sufficient power,[48,51,60,61] and only three controlled for a range of established socio-demographic confounders.[47,51,53]

Despite these results, the synthesis identified clear trends in the research findings with 36 (80%) analyses from 25 (76%) studies demonstrating findings. Six studies found an inverse relationship between PPA and exclusive breastfeeding.[24,45,49,52,54,55] Four cohort studies revealed that higher levels of PPA were associated with a reduction in exclusive breastfeeding in the first six months postpartum.[45,49,52,55] Findings from two cross sectional studies also observed that PPA is lower among those that practice exclusive breastfeeding.[24,54] Despite variation in measurement tools and timings, these results were apparent in all of the studies after controlling for a range of confounders.

Furthermore, ten studies found a negative relationship between PPA and breastfeeding in any quantity. Five of these reported associations between PPA and reduced breastfeeding activity in the early postpartum (<3 months),[45,46,50,57,58] while five more provided evidence for the impact of anxiety on continued breastfeeding (>3 months and <12 months).[1,38,47,49,56] Only one of these studies failed to control for socio-demographic confounders.[50]

Despite clear trends for breastfeeding exclusivity and duration, there was mixed evidence for the association between PPA and breastfeeding initiation. Some studies found that higher anxiety was associated with reduced breastfeeding initiation and increased formula supplementation in hospital,[44–46]. Others found that a diagnosis of immediate or later clinical anxiety was more likely in women who initiated breastfeeding.[42,43] Xu's (2014) population-based study indicates a clear directional effect of breastfeeding initiation on anxiety-related hospital admissions.[43] However, Call's (1959) work was dated and at risk of bias; additional research using clinical diagnostic measures is warranted to clarify this relationship.[42]

Four studies found that PPA was associated with negative maternal attitudes, specifically lower confidence,[45,62] lower preference for breastfeeding, and the belief that breastfeeding is restrictive and should be private.[63,64] Both studies examining maternal self-efficacy used the state anxiety scale in the early postpartum,[45,62] indicating that mothers with early situational anxiety are less confident in their ability to breastfeed. As mentioned in Dennis's (2009) review of PPD and infant feeding, this is particularly significant given the well-established relationship between breastfeeding self-efficacy and breastfeeding initiation, duration and exclusivity.[14,15,29] Two pilot intervention studies to increase breastfeeding self-efficacy have been conducted recently showing good feasibility,[71,72] and an inverse relationship between self-efficacy and anxiety.[72] Repetition on a larger scale is necessary while accounting for postpartum differences in mood.

Diverse evidence for the relationship between PPA and maternal and infant-feeding behaviours was found. Two studies found a positive association between PPA and infant-feeding difficulties.[50,67] This relationship may occur via two pathways: (1) anxiety induces biased cognitive processes,[73] which influence maternal perceptions of feeding difficulties; or (2) PPA affects early mother-infant interactions,[74] which may subsequently bring about the onset of actual feeding difficulties. Two studies in the review highlighted an immediate impact of state anxiety during feeding sessions on feeding behaviours[65,66] which provides further evidence for the latter argument.

Finally, there is emerging evidence for the relationship between PPA (particularly state anxiety) and levels of specific breast milk components, namely a reduction in Sig A which provides infants with immunity against common pathogens,[69] β-EP, an opioid analgesic implicated in attachment formation,[22] and elevated levels of sodium which are linked to impaired lactation and neonatal weight loss.[70,75,76] Heterogeneity in outcomes limits their comparability. However, the relationship between PPA and breast milk composition remains relatively unexplored and the evidence presented highlights that PPA may affect breast milk components which are important in predicting breastfeeding success[70] and infant health outcomes.[22,69] More work is needed in this area.

Although the synthesis provides strong evidence for the relationship between PPA and a range of negative infant-feeding outcomes throughout the postpartum period and across diverse populations, methodological limitations were prevalent and comparable to those noted in similar reviews.[29,30] Definitions of breastfeeding were disparate among studies with few using established classifications.[24,45,55] Only six studies examining feeding methods provided confirmation of whether women actually initiated breastfeeding.[38,44,45,50,57,58] Failure to do this may confound results by combining women who discontinued breastfeeding

early, and those who exclusively formula fed from birth. Sample sizes were small (<100) in 13 studies[22,48,51,54,58,60,61,65–70] and may have lacked sufficient power. In addition, many of the samples were homogenous in terms of nationality, ethnicity, and hospital of delivery [22,39,42,48,51,56,61,63–65,68–70] which may limit the generalizability of findings. Other samples were much more diverse with regards to these characteristics,[43,44,46,49,53,59] but comparing results across sample attributes was unfeasible due to differences in methodology, exposure and outcome.

In terms of measurement, all of the studies used self-report tools, with only three using diagnostic criteria for anxiety.[1,42,43] However, unlike the PPD review which predominately reported findings using the EPDS, there was vast heterogeneity in measures of PPA across studies; many of which were subscales[24,46,47,53,57,60,61,68,69] and not validated in perinatal populations.[77] Despite many studies utilising the STAI[1,38,39,44,45,48–52,55,56,58,59,62,65–68] which may be the most useful tool for research purposes,[77] a widely accepted perinatal measurement tool to screen for PPA is needed. Furthermore, there were some studies excluded from the review which failed to separate anxiety from depression.[78–82] The three-item EPDS anxiety subscale has been identified as a valid and reliable short scale,[83] but was not analysed separately in any of the studies; it is suggested that researchers utilise this in future PPD research to simultaneously expand the existing evidence base for anxiety. The methodological variability noted across studies meant examining patterns of results according to design or measurement was unviable and reiterates previous suggestions of a need for standardisation in the field to aid comparability of findings.[29,30]

Despite these limitations, the review provides evidence to suggest that women with PPA are less likely to breastfeed exclusively, and more likely to terminate breastfeeding earlier. There is also some evidence to suggest that those with high levels of anxiety are less likely to

initiate breastfeeding and more likely to supplement with formula in the hospital. In those that do breastfeed, PPA reduces self-efficacy, increases breastfeeding difficulties, and may negatively affect breastfeeding behaviours and breast milk composition. From a clinical perspective, PPA remains among the most under-diagnosed, and undertreated complications of childbirth.[84] This is largely due to the 'shadowing effect' of PPD. Despite high comorbidity, a patient who is anxious and depressed will be labelled depressed as depression supersedes anxiety diagnostically.[85] Given the diverse evidence base linking PPA with maternal and infant health outcomes,[2,4] assessment of both disorders is warranted when examining the mental health of new mothers.[85,86] Non-pharmacological, postpartum-specific anxiety management strategies such as cognitive and behavioural therapies, routine management guidance, and maternal and infant self-care advice may be preferable for breastfeeding mothers given their low acceptability of pharmacologic interventions.[29] Sensitive, non-judgemental support for those who discontinue breastfeeding prematurely is necessary to minimise further maternal distress. Interventions to support breastfeeding mothers experiencing anxiety have not been conducted and may help to minimise PPA and the potential for subsequent negative infant-feeding outcomes.

Conclusions

The review findings suggest that women in the postnatal period who experience symptoms of anxiety are at an increased risk of suboptimal infant-feeding outcomes. Improving identification and treatment of PPA is critical for maternal and infant health. In combination with the evidence linking PPD with poorer infant-feeding outcomes,[29] there is evidence to support intervention studies of breastfeeding mothers with negative postpartum mood states.

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Abbreviations: PPA – Postpartum Anxiety

PPD – Postpartum Depression

ICD-10 – International Classification of Diseases (10^{th} Revision)

STAI – State Trait Anxiety Inventory

HAM-A – Hamilton Anxiety Scale

POMS – Profile of Mood States

DASS-21 – Depression, Anxiety and Stress Scales

IPSQ – Infancy Parenting Styles Questionnaire

MAS – Maternal Adjustment Scale

NOS – Newcastle Ottawa Quality Assessment Scale

CI – Confidence Interval

OR – Odds Ratio

AOR – Adjusted Odds Ratio

CPH – Cox Proportional Hazard

HR: Hazard Ratio

References

1. Paul IM, Downs DS, Schaefer EW, Beiler JS, Weisman CS. Postpartum anxiety and maternal-infant health outcomes. *Pediatrics*. 2013;131(4):e1218-e1224. doi:10.1542/peds.2012-2147.

2. Glasheen C, Richardson G a., Fabio A. A systematic review of the effects of postnatal maternal anxiety on children. *Arch Womens Ment Health*. 2010;13(1):61-74. doi:10.1007/s00737-009-0109-y.

3. Wenzel A, Haugen EN, Jackson LC, Robinson K. Prevalence of generalized anxiety at eight weeks postpartum. *Arch Womens Ment Health*. 2003;6(1):43-49. doi:10.1007/s00737-002-0154-2.

4. Lonstein JS. Regulation of anxiety during the postpartum period. *Front Neuroendocrinol*. 2007;28(2-3):115-141. doi:10.1016/j.yfrne.2007.05.002.

5. Manassis K, Bradley S, Goldberg S, Hood J, Swinson RP. Attachment in mothers with anxiety disorders and their children. *J Am Acad Child Adolesc Psychiatry*. 1994;33(8):1106-1113. doi:10.1097/00004583-199410000-00006.

6. Galler JR, Harrison RH, Ramsey F, Forde V, Butler SC. Maternal depressive symptoms affect infant cognitive development in Barbados. *J Child Psychol Psychiatry*. 2000;41(6):747-757. doi:10.1111/1469-7610.00662.

7. Coplan RJ, O'Neil K, Arbeau K. Maternal anxiety during and after pregnancy and infant temperament at three months of age. *J Prenat Perinat Psychol Heal*.

2005;19(3):199-215. doi:http://dx.doi.org/10.1108/17506200710779521.

8. Feldman R, Granat A, Pariente C, Kanety H, Kuint J, Gilboa-Schechtman E. Maternal depression and anxiety across the postpartum year and infant social engagement, fear regulation, and stress reactivity. *J Am Acad Child Adolesc Psychiatry*. 2009;48(9):919-927. doi:10.1097/CHI.0b013e3181b21651.

9. Lauzon-Guillain B De, Wijndaele K, Clark M, et al. Breastfeeding and infant temperament at age three months. *PLoS One*. 2012;7(1):e29326. doi:10.1371/journal.pone.0029326.

10. Tharner A, Luijk MPCM, Raat H, et al. Breastfeeding and Its Relation to Maternal Sensitivity and Infant Attachment. *J Dev Behav Pediatr*. 2012;33(5):396-404. doi:10.1097/DBP.0b013e318257fac3.

11. Mortensen EL. Life course consequences of breastfeeding. *Lancet Glob Heal*. 2015;3(4):e179-e180. doi:10.1016/S2214-109X(15)70078-1.

12. Porter CL, Hsu H-C. First-time mothers' perceptions of efficacy during the transition to motherhood: links to infant temperament. *J Fam Psychol*. 2003;17(1):54-64. doi:10.1037/0893-3200.17.1.54.

13. Mertesacker B, Bade U, Haverkock A, Pauli-Pott U. Predicting maternal reactivity/sensitivity: The role of infant emotionality, maternal depressiveness/anxiety, and social support. *Infant Ment Health J*. 2004;25(1):47-61. doi:10.1002/imhj.10085.

14. Blyth R, Creedy DK, Dennis CL, Moyle W, Pratt J, De Vries SM. Effect of maternal confidence on breastfeeding duration: An application of breastfeeding self-efficacy theory. *Birth*. 2002;29(4):278-284. doi:10.1046/j.1523-536X.2002.00202.x.

15. Ystrom E, Niegel S, Klepp KI, Vollrath ME. The Impact of Maternal Negative Affectivity and General Self-Efficacy on Breastfeeding: The Norwegian Mother and

Child Cohort Study. *J Pediatr*. 2008;152(1):68-72. doi:10.1016/j.jpeds.2007.06.005.

16. Dennis. Theoretical underpinnings of breastfeeding confidence: A self-efficacy framework. *J Hum Lact*. 2002;15:195.

17. Britton JR, Britton HL, Gronwaldt V. Breastfeeding, sensitivity, and attachment. *Pediatrics*. 2006;118(5):e1436-e1443. doi:10.1542/peds.2005-2916.

18. Else-Quest NM, Hyde JS, Clark R. Breastfeeding, Bonding, and the Mother-infant Relationship. *Merrill Palmer Q*. 2003;49(4):495-517. doi:10.2307/23096091.

19. Kim P, Feldman R, Mayes L, et al. Breastfeeding, Brain Activation to Own Infant Cry, and Maternal Sensitivity. *J Child Psychol Psychiatry*. 2011;52(8):907-915. doi:10.1038/nature13314.A.

20. Dewey KG. Maternal and Fetal Stress Are Associated with Impaired Lactogenesis in Humans. *J Nutr*. 2001:3009-3011.

21. Stuebe AM, Grewen K, Pedersen C a, Propper C, Meltzer-Brody S. Failed lactation and perinatal depression: common problems with shared neuroendocrine mechanisms? *J Womens Health (Larchmt)*. 2012;21(3):264-272. doi:10.1089/jwh.2011.3083.

22. Zanardo V, Nicolussi S, Favaro F, et al. Effect of postpartum anxiety on the colostral milk beta-endorphin concentrations of breastfeeding mothers. *J Obstet Gynaecol*. 2001;21(2):130-134. doi:10.1080/01443610020026001.

23. Chen DC, Nommsen-rivers L, Dewey KG, Lönnerdal B. Stress during labor and delivery and early lactation performance. *Am J Clin Nutr*. 1998;68(4):335-344.

24. Groër MW. Differences Between Exclusive Breastfeeders, Formula-Feeders, and Controls: A Study of Stress, Mood, and Endocrine Variables. *Biol Res Nurs*. 2005;7(2):106-117. doi:10.1177/1099800405280936.

25. Groer M., Wilkinson Davis M. Postpartum Stress: Current Concepts and the Possible Protective Role of Breastfeeding. *JOGNN - J Obstet Gynecol Neonatal Nurs*. 2002;31(4):411-417.

26. Tu MT, Lupien SJ, Walker C-D. Measuring stress responses in postpartum mothers: perspectives from studies in human and animal populations. *Stress*. 2005;8(1):19-34. doi:10.1080/10253890500103806.

27. Heinrichs M. Effects of Suckling on Hypothalamic-Pituitary-Adrenal Axis Responses to Psychosocial Stress in Postpartum Lactating Women. *J Clin Endocrinol Metab*. 2001;86(10):4798-4804. doi:10.1210/jc.86.10.4798.

28. Heinrichs M, Neumann I, Ehlert U. Lactation and stress: protective effects of breast-feeding in humans. *Stress*. 2002;5(3):195-203. doi:10.1080/1025389021000010530.

29. Dennis C-L, McQueen K. The Relationship Between Infant-Feeding Outcomes and Postpartum Depression: A Qualitative Systematic Review. *Pediatrics*. 2009;123(4):e736-e751. doi:10.1542/peds.2008-1629.

30. Fallon V, Bennett KM, Harrold J a. Prenatal Anxiety and Infant Feeding Outcomes: A Systematic Review. *J Hum Lact*. 2015;(October). doi:10.1177/0890334415604129.

31. Bolling K, Grant C, Hamlyn B, Thornton A. Infant Feeding Survey 2005. *Heal Soc Care Inf Cent*. 2005.

32. Australian Institute of Health and Welfare. Australian National Infant Feeding Survey. 2010 Australian National Infant Feeding Survey. http://www.aihw.gov.au/publication-detail/?id=10737420927. Published 2011. Accessed September 1, 2015.

33. Health Canada. Duration of Exclusive Breastfeeding in Canada: Key Statistics and Graphics. Duration of Exclusive Breastfeeding in Canada: Key Statistics and Graphics (2009-2010). http://www.hc-sc.gc.ca/fn-

an/surveill/nutrition/commun/prenatal/exclusive-exclusif-eng.php. Published 2011. Accessed September 1, 2015.

34. Centers for Disease Control and Prevention. Centers for Disease Control and Prevention National Immunisation Survey. Breastfeeding among U.S. Children Born 2002–2012. http://www.cdc.gov/breastfeeding/data/NIS_data/. Published 2015. Accessed September 1, 2015.

35. Holditch-Davis D, Santos H, Levy J, et al. Patterns of psychological distress in mothers of preterm infants. *Infant Behav Dev*. 2015;41:154-163. doi:10.1016/j.infbeh.2015.10.004.

36. Zelkowitz P, Feeley N, Shrier I, et al. The Cues and Care Trial: a randomized controlled trial of an intervention to reduce maternal anxiety and improve developmental outcomes in very low birthweight infants. *BMC Pediatr*. 2008;8:38. doi:10.1186/1471-2431-8-38.

37. Moran TE, Polanin JR, Segre L, Wenzel A. The postpartum worry scale—Revised: Continuing validation with a sample of NICU mothers. *Arch Womens Ment Health*. 2015;18(2):221-228. doi:10.1007/s00737-014-0452-5.

38. Courtois E, Lacombe M, Tyzio S. Facteurs associ{é}s a la poursuite de l'allaitement jusqu'{à} 6 mois chez les m{è}res allaitantes dans une maternit{é} parisienne. *Rech Soins Infirm*. 2014;(117):50-64. doi:10.3917/rsi.117.0050.

39. Aragaki I. Estudo sobre o traco e estado de ansiedade das nutrizes que aprestenteram indicadores de hipogalactia e nutrizes com galactia normal. 2002.

40. Higgins JP., Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions*. Version 5. The Cochrane Collaboration; 2011. www.cochranehandbook.org.

41. Shea B, Robertson J, Peterson J, Welch V, Losos M. The Newcastle-Ottawa Scale (NOS) for Assessing the Quality of Nonrandomized Studies in Meta- Analysis Bias and Confounding Newcastle-Ottowa Scale. http://www.evidencebasedpublichealth.de/download/Newcastle_Ottowa_Scale_Pope_Bruce.pdf. Published 2012. Accessed September 30, 2014.

42. Call J. Emotional Factors Favoring Successful Breastfeeding of Infants. *J Pediatr*. 1959;55:485-496.

43. Xu F, Li Z, Binns C, Bonello M, Austin M-P, Sullivan E. Does infant feeding method impact on maternal mental health? *Breastfeed Med*. 2014;9(4):215-221. doi:10.1089/bfm.2013.0142.

44. Gagnon A., Leduc G, Waghorn K, Yang H, Platt R. In-hospital formula supplementation of healthy breastfeeding newborns. *J Hum Lact*. 2005;21(4):397-405.

45. Britton JR. Postpartum Anxiety and Breastfeeding. *J Reprod Med*. 2007;52(8):689-695.

46. Brown A, Arnott B. Breastfeeding duration and early parenting behaviour: the importance of an infant-led, responsive style. *PLoS One*. 2014;9(2):e83893. doi:10.1371/journal.pone.0083893.

47. Turner C., Papinczak T. An analysis of personal and social factors influencing initiation and duration of breastfeeding in a large Queensland maternity hospital. *Breastfeed Rev*. 2000;8(1):25-33.

48. Taylor C. Anxiety levels in breast feeding and bottle feeding primiparas. 1987.

49. Adedinsewo D a, Fleming AS, Steiner M, Meaney MJ, Girard AW. Maternal anxiety and breastfeeding: findings from the MAVAN (Maternal Adversity, Vulnerability and Neurodevelopment) Study. *J Hum Lact*. 2014;30(1):102-109.

doi:10.1177/0890334413504244.

50. Hellin K, Waller G. Mothers' mood and infant feeding: Prediction of problems and practices. *J Reprod Infant Psychol*. 1992;10(1):39-51. doi:10.1080/02646839208403267.

51. Akman I, Kuscu MK, Yurdakul Z, et al. Breastfeeding duration and postpartum psychological adjustment: role of maternal attachment styles. *J Paediatr Child Health*. 2008;44(6):369-373. doi:10.1111/j.1440-1754.2008.01336.x.

52. Clifford TJ. Factors Influencing Full Breastfeeding in a Southwestern Ontario Community: Assessments at 1 Week and at 6 Months Postpartum. *J Hum Lact*. 2006;22(3):292-304. doi:10.1177/0890334406290043.

53. O'Brien M, Buikstra E, Hegney D. The influence of psychological factors on breastfeeding duration. *J Adv Nurs*. 2008;63(4):397-408. doi:10.1111/j.1365-2648.2008.04722.x.

54. Virden SF. The relationship between infant feeding method and maternal role adjustment. *J Nurse Midwifery*. 1988;33(1):31-35. doi:10.1016/0091-2182(88)90246-7.

55. Zanardo V, Gasparetto S, Giustardi A, et al. Impact of anxiety in the puerperium on breast-feeding outcomes: role of parity. *J Pediatr Gastroenterol Nutr*. 2009;49(5):631-634. doi:10.1097/MPG.0b013e31819e6446.

56. Tinkle M. An ecological analysis of breast feeding outcomes with implications for nursing intervention strategies. 1985.

57. Dusdieker LB, Booth BM, Seals BF, Ekwo EE. Investigation of a Model for the Initiation of Breastfeeding in Primigravida women. 1985;20(7):695-703.

58. Buckner E. Interrelationship of Information, Anxiety, Network and Milk Production

During Early Breastfeeding and Effect on Continuation. 1987.

59. Cooke M, Schmied V, Sheehan A. An exploration of the relationship between postnatal distress and maternal role attainment, breast feeding problems and breast feeding cessation in Australia. *Midwifery*. 2007;23(1):66-76. doi:10.1016/j.midw.2005.12.003.

60. Mezzacappa ES, Katkin ES. Breast-feeding is associated with reduced perceived stress and negative mood in mothers. *Heal Psychol*. 2002;21(2):187-191. doi:10.1037//0278-6133.21.2.187.

61. Wiesenfeld A., Malatesta C., Whitman P., Granrose C, Uili R. Psychophysiological response of breast- and bottle-feeding mothers to their infants. *Psychophysiology*. 1985;22(1):81-86.

62. Dennis C-L. Identifying predictors of breastfeeding self-efficacy in the immediate postpartum period. *Res Nurs Health*. 2006;29:256-258. doi:10.1002/nur.

63. Galler JR, Harrison RH, Ramsey F, Chawla S, Taylor J. Postpartum feeding attitudes, maternal depression, and breastfeeding in Barbados. *Infant Behav Dev*. 2006;29(2):189-203. doi:10.1016/j.infbeh.2005.10.005.

64. Galler JR, Harrison RH, Biggs M., Ramsey F, Forde V. Maternal moods predict breastfeeding in Barbados. *Dev Behav Pediatr*. 1999;20(2):80-88.

65. Blank D. Relating Mothers' Anxiety and Perception to Infant Satiety, Anxiety, and Feeding Behavior. *Nurs Res*. 1986;35(6):347-351.

66. Hart SL, Jackson SC, Boylan LM. Compromised weight gain, milk intake, and feeding behavior in breastfed newborns of depressive mothers. *J Pediatr Psychol*. 2011;36(8):942-950. doi:10.1093/jpepsy/jsr031.

67. Richter N, Reck C. Positive maternal interaction behavior moderates the relation

between maternal anxiety and infant regulatory problems. *Infant Behav Dev*. 2013;36(4):498-506. doi:10.1016/j.infbeh.2013.04.007.

68. Hart S, Boylan LM, Border B, Carroll SR, McGunegle D, Lampe RM. Breast milk levels of cortisol and Secretory Immunoglobulin A (SIgA) differ with maternal mood and infant neuro-behavioral functioning. *Infant Behav Dev*. 2004;27(1):101-106. doi:10.1016/j.infbeh.2003.06.002.

69. Kawano A, Emori Y. The Relationship Between Maternal Postpartum Psychological State and Breast Milk Secretory Immunoglobulin A Level. *J Am Psychiatr Nurses Assoc*. 2015;21(1):23-30. doi:10.1177/1078390314566882.

70. Ozbek A, Kumral A, Guvenir T, et al. Maternal psychosocial aspects in hypernatremic dehydration with high sodium concentrations in breast milk: A case-control study. *J Paediatr Child Health*. 2008;44(1-2):38-43. doi:10.1111/j.1440-1754.2007.01208.x.

71. Mcqueen K a., Dennis CL, Stremler R, Norman CD. A Pilot Randomized Controlled Trial of a Breastfeeding Self-Efficacy Intervention With Primiparous Mothers. *JOGNN - J Obstet Gynecol Neonatal Nurs*. 2011;40(1):35-46. doi:10.1111/j.1552-6909.2010.01210.x.

72. Perez-Blasco J, Viguer P, Rodrigo MF. Effects of a mindfulness-based intervention on psychological distress, well-being, and maternal self-efficacy in breast-feeding mothers: Results of a pilot study. *Arch Womens Ment Health*. 2013;16(3):227-236. doi:10.1007/s00737-013-0337-z.

73. Maloney E a., Sattizahn JR, Beilock SL. Anxiety and cognition. *Wiley Interdiscip Rev Cogn Sci*. 2014;5(4):403-411. doi:10.1002/wcs.1299.

74. Nicol-Harper R, Harvey AG, Stein A. Interactions between mothers and infants: Impact of maternal anxiety. *Infant Behav Dev*. 2007;30(1):161-167.

doi:10.1016/j.infbeh.2006.08.005.

75. Manganaro R, Marseglia L, Mamì C, et al. Breast milk sodium concentration, sodium intake and weight loss in breast-feeding newborn infants. *Br J Nutr*. 2007;97(2):344-348. doi:10.1017/S0007114507280572.

76. Morton J. The Clinical Usefulness of Breast Milk Sodium in the Assessment of Lactogenesis. *Pediatrics*. 1994;93(5):802-806.

77. Meades R, Ayers S. Anxiety measures validated in perinatal populations: a systematic review. *J Affect Disord*. 2011;133(1-2):1-15. doi:10.1016/j.jad.2010.10.009.

78. Ystrom E. Breastfeeding cessation and symptoms of anxiety and depression: a longitudinal cohort study. *BMC Pregnancy Childbirth*. 2012;12:36. doi:10.1186/1471-2393-12-36.

79. Micali N, Simonoff E, Stahl D, Treasure J. Maternal eating disorders and infant feeding difficulties: Maternal and child mediators in a longitudinal general population study. *J Child Psychol Psychiatry Allied Discip*. 2011;52(7):800-807. doi:10.1111/j.1469-7610.2010.02341.x.

80. Ali NS, Ali BS, Azam IS. Post partum anxiety and depression in peri-urban communities of Karachi, Pakistan: a quasi-experimental study. *BMC Public Health*. 2009;9:384. doi:10.1186/1471-2458-9-384.

81. Forster D a, McLachlan HL, Lumley J. Factors associated with breastfeeding at six months postpartum in a group of Australian women. *Int Breastfeed J*. 2006;1:18. doi:10.1186/1746-4358-1-18.

82. Taj R, Sikander KS. Effects of maternal depression on breast-feeding. *J Pak Med Assoc*. 2003;53(1):8-11.

83. Matthey S. Using the Edinburgh Postnatal Depression Scale to screen for anxiety

disorders. *Depress Anxiety*. 2008;25:926-931. doi:10.1002/da.20415.

84. Smith T, Kipnis G. "Implementing a perinatal mood and anxiety disorders program." *MCN Am J Matern Nurs*. 2012;37(3):199. doi:10.1097/NMC.0b013e3182598cfb.

85. Matthey S, Barnett B, Howie P, Kavanagh DJ. Diagnosing postpartum depression in mothers and fathers: Whatever happened to anxiety? *J Affect Disord*. 2003;74(2):139-147. doi:10.1016/S0165-0327(02)00012-5.

86. Ross LE, Evans SEG, Sellers EM, Romach MK. Measurement issues in postpartum depression part 1: Anxiety as a feature of postpartum depression. *Arch Womens Ment Health*. 2003;6(1):51-57. doi:10.1007/s00737-002-0155-1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria
• Published or unpublished literature in any language • Sub-clinical, self-reported symptoms or clinical diagnosis of anxiety occurring during the first year postpartum • Any current or previous infant feeding attitude, behaviour or biological sequelae (i.e. breast milk composition) • Studies examining postnatal depression which use an anxiety subscale and report analyses for anxiety separately • Prenatal anxiety if postnatal anxiety was also assessed and analyses were reported separately
Exclusion Criteria
• Historical literature (> 100 years) • Sub-clinical or clinical diagnosis of anxiety occurring pre-pregnancy • Other mental health conditions (i.e. postpartum blues, postpartum psychosis, prenatal depression, prenatal anxiety*, prenatal depression, postpartum depression*) occurring during pregnancy or the postpartum • Mothers of infants in SCBU or NICU at time of study • Mothers of premature (<37 weeks) or VLBW (<1500g) infant • Mothers of infants with specific health problems known to affect feeding

*excluded if they did not also examine and provide separate analyses for postpartum anxiety

Table 2: Manuscripts Included That Examined the Relationship between Postpartum Anxiety and Infant Feeding Outcomes

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and Breastfeeding Initiation							
	Adedinsewo et al. (2014)[31]	Prospective cohort study	306 Canadian women recruited from maternity hospital in Hamilton. Included women from socio-demographically disadvantaged population and women who screened positively for antenatal anxiety	HAM-A 3 months PP. STAI at 3 and 6 months postpartum	Self-report question administered at 3 months PP with option of responding that they never BF or provided BM for their baby	94.2% of women initiated BF meaning there was insufficient variance to assess differences across anxiety levels	Unusually high prevalence of BF initiation. No depression measure included. Did not use clinical cut-offs for anxiety measures. Comprehensive range of confounders accounted for.
	Britton (2007)[45]	Prospective cohort study	973 US women university medical centre, 422 completed pre-discharge survey	STAI (state) administered at hopital discharge	BF initiation immediately after delivery and in hospital formula supplementation	Mothers who BF immediately after birth and did not supplement with formula during their hospital stay had significantly lower anxiety scores than those who did not.	Bivariate analyses only. Clear definition of BF initiation. No depression measure included. Results were significant when anxiety was analysed categorically and continuously.
	Brown & Arnott (2014)[46]	Cross sectional survey (paper based and online	508 UK mothers with an infant aged between 0-12 months located in areas of varying deprivation to encourage a wide demographic group	4 item anxiety sub-scale of the Infancy Parenting Styles Questionnaire (IPSQ)	Self-report question retrospectively enquiring whether participants had BF, fed EBM, or FF at birth	Mothers who initiated BF had significantly lower anxiety levels when compared to mothers who fed EBM or FF. No difference was found between those who fed EBM or FF	Postpartum specific measure of anxiety, although only a subscale. No depression measure included. Included those who fed EBM in analysis. Comprehensive range of confounders accounted for.
	Call (1959)[42]	Cross sectional study	104 mothers from 1 US hospital - split into 50 primiparous and 54 multiparous and analysed separately	Group/single observations in hospital PP by one interviewer trained in pediatrics and psychiatry – categorised as either anxious/calm	Self report question – categorised as those who EFF from birth and those who initiated BF in hospital	Primiparous and multiparous mothers who initiate BF are more anxious in the very early PP than those who initiate FF	Dated manuscript. No inferential statistics conducted. Large potential for interviewer bias when categorising anxiety. No depression measure taken.
	Gagnon et al. (2005)[44]	Cross sectional study	564 Canadian women recruited from university hospital as part of wider RCT - representative sample. All initiated BF, all highly motivated to BF with partners supportive of BF.	STAI measured at two weeks PP and dichotomised into high/low	Initial formula supplementation in hospital abstracted from medical records	High maternal trait anxiety was predictive of up to 2.5 times more supplementation in hospital. No significant relationship between state anxiety and supplementation	Reverse causality bias - could be that supplementation led to an increase in trait scores (trait scores taken after hospital stay). Justified sample size. Comprehensive range of confounders accounted for. No depression measure taken.

Table 2. Continued

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and BF initiation							
	Hellin & Waller (1992)[50]	Prospective cohort study	145 UK women recruited from district hospital. 76 women completed measures at 1 week, 111 completed measures at 5 months	STAI (state and trait) at 1 week and 5 months PP	Women were asked if they had BF at all or not (BF not defined) some months after delivery (actual time PP not specified)	No significant difference in anxiety (state or trait) at 1 week or 5 months between those who had initiated BF and those who had not	Antenatal anxiety measurement also collected. Depression measure taken. Multiple anxiety assessments
	Papinczak & Turner (2000)[47]	Prospective cohort study	159 Australian mothers recruited from a group of 210 from a women's hospital in Brisbane. 30 controls randomly selected from this group were not interviewed at 3 months to measure the effect of interview or bias on BF outcomes, no difference between control and study group.	Duke Health Profile (anxiety subscale) self-report at 3 months PP	BF initiation defined as one successful BF before hospital discharge	No significant difference in anxiety scores at 3 months PP between those who initiated BF in hospital and those who did not	Low loss to follow-up at 3 months. Subscale used to measure anxiety. Depression subscale also used. Small sample size had capacity to reduce power in multivariate analyses. Comprehensive range of confounders accounted for.
	Taylor (1987)[48]	Cross sectional study	36 primiparous women from US hospital, Sampled for women with no maternal and infant complications	STAI-S (state only) administered during hospital stay, trait anxiety data collected but analysed as covariate	Self-report question regarding feeding method during hospital stay collected post-delivery	With trait anxiety controlled, there was no difference in state anxiety levels between participants who initiated BF and those who did not.	Dated thesis. Aside from trait anxiety, no confounders accounted for. Potentially inappropriate parametric analysis given small sample size and no mention of parametric assumptions. No depression measure taken. No definitions of BF provided.
	Xu et al. (2014)[43]	Population-based longitudinal cohort study	186452 Australian women- all mothers who gave birth in NSW, Australia between 2007/8.	Hospital admission for anxiety disorders in the first 12 months PP coded according to ICD-10. Ascertained via record linkage	Feeding status on discharge (BF, EBM, FF) ascertained via record linkage	Mothers who were FF at discharge were less likely to be admitted to hospital within 12 months after birth with a diagnosis of anxiety disorders	Only accounts for cases of anxiety that result in hospital admission. Clinical diagnostic measure of PPA. Depression admissions also analysed. No antenatal psychiatric history. Comprehensive range of confounders accounted for.
PPA and EBF duration							
	Adedisewo et al. (2014)[49]	Prospective cohort study	306 Canadian women recruited from maternity hospital in Hamilton. Included women from socio-demographically disadvantaged population and women who screened positively for antenatal anxiety	HAM-A 3 months PP. STAI at 3 and 6 months postpartum	EBF at 3 and 6 months PP ascertained via self report question querying the age of the baby when fed with something other than breast milk.	A single point increase in HAMA at 3 months was associated with an 11% reduction in EBF at 6 months. No other effects found for STAI or EBF at 3 months.	No depression measure included. Did not use clinical cut-offs for anxiety measures. Comprehensive range of confounders accounted for.

Table 2. Continued

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and EBF duration							
	Akman et al. (2008)[51]	Prospective cohort study	60 Turkish mothers from University hospital. Homogenous sample.	STAI in the 1st month postpartum	EBF status at 4 months abstracted from perinatal records	No significant differences between state or trait anxiety scores at 1 month and EBF status (yes/no) at 4 months PP	Part of a wider study examining feeding and attachment. Small, homogenous sample. NP test. No definition of EBF provided. Very high EBF rates in the overall sample. Comprehensive range of confounders accounted for. EPDS also administered.
	Britton (2007)[45]	Prospective cohort study	973 US women university medical centre, 422 completed pre-discharge survey, 265 completed 1 month survey (only BF mothers at time of hospital discharge were included)	STAI (state) administered at hopital discharge and 1 month PP	EBF at 1 month (as defined by Labbok & Krasovec, 1990)	Women with higher state anxiety both pre-discharge and 1 month (measured either categorically or dimensionally) were less likely to practice full EBF at 1 month.	Clear definition of EBF. Multiple anxiety assessments. Comprehensive range of confounders accounted for. No depression measure included.
	Clifford et al. (2006)[52]	Prospective cohort study	856 Canadian women from 2 Ontario hospitals. 560 completed 6 month questionnaire. Participants were more likely to be married, well educated, better income, older and more likely to have continued BF than those who dropped out	STAI state and trait at 1 week and 6 mo PP - dichotomised into high/low anxiety using 75th percentile	EBF at 1 week and 6 months PP (no definition)	Trait anxiety at 1 week PP was a significant risk factor for ceasing EBF in the first 6 months PP. No other associations found.	EPDS also administered. Comprehensive range of confounders accounted for. Clear description of those lost to follow up. No definition of EBF provided
	Groer (2005)[24]	Cross sectional study	183 US mothers recruited from US hospital and physician offices. 300 initially recruited but mothers who had supplemented were excluded. 33 controls (non-postpartum student nurses) also recruited	POMS (anxiety subscale) at 4-6 weeks PP	Feeding method at 4-6 weeks PP (EBF - never supplemented, EFF - never BF & control)	Participants who EBF to 4-6 weeks had significantly lower levels of anxiety when compared to EFF and a non-postpartum control group	Anxiety subscale used. Depression subscale also used. Comprehensive range of confounders accounted for. Only study to use a non-postpartum control group.
	O'Brien et al. (2008)[53]	Prospective cohort study	657 eligible women from large regional centre in Queensland - inc 2 maternity units (1 private, 1 public). 375 returned questionnaires within 14 days PP (T1), 15% attrition rate between T1 and T2 (6 months PP)	Depression, Anxiety and Stress Scale 21 - DASS 21 (anxiety subscale) returned within 2 weeks PP	EBF at 26 weeks PP ascertained via telephone interview	Anxiety in the first two weeks PP was not significantly associated with EBF at 26 weeks	Subscale used to measure PPA. Comprehensive range of confounders accounted for. Depression subscale also used. No comparison between responders or non-responders although attrition was low. Current Australian guidelines used to define BF.

Table 2. Continued

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and EBF duration							
	Virden (1988)[54]	Cross sectional study	60 primiparous US women recruited from two hospitals (one private, one public). Ethnically diverse sample.	Maternal Attitude Scale (MAS) - 14 item anxiety subscale administered between 4-6 weeks PP	Feeding method at 4-6 weeks postpartum (EBF EFF, combination of breast and bottle)	Main effect of feeding method on anxiety levels. No post-hoc tests conducted but EBF mothers had clear lower mean anxiety than the other two groups (Combi, EFF)	Anxiety subscale used. Postpartum specific measure. No depression measure taken. No definitions of BF provided. Homogeneity of variance violated due to high dispersion of scores in FF group. Inappropriate analyses therefore reported and findings should be viewed accordingly. May be due to small sample size. Some confounders accounted for.
	Zanardo et al. (2009)[55]	Prospective cohort study	204 (101 primiparous, 103 multiparous) Italian mothers from general hospital in Veneto	STAI at 3-4 days postpartum - researcher administered during interview	EBF success for longer than 3 months ascertained via telephone call	Primiparous women with higher state anxiety levels in the immediate postpartum are less likely to EBF for longer than 3 months. No difference between trait anxiety and EBF for longer than 3 months. No analyses for multiparous group	High rates of BF initiation. Used WHO criteria for BF. Only age, education, and type of delivery controlled for. No depression measure taken.
PPA and any BF duration							
	Adedinsewo et al. (2014)[49]	Prospective cohort study	306 Canadian women recruited from maternity hospital in Hamilton. Included women from socio-demographically disadvantaged population and women who screened positively for antenatal anxiety	HAM-A 3 months PP. STAI at 3 and 6 months postpartum	Any BF at 6 and 12 months. Self report question asking the age of baby (in weeks) when mothers stopped providing any breast milk	A single point increase in STAI (state and trait) scores at 3 months was associated with a 4% and 7% reduction in the odds of any BF at 12 months respectively. No differences found for HAM-A at 3 months or STAI at 6 months	Different anxiety scales found different results. No depression measure taken. Small sample size may have had insufficient power. Did not utilise clinical cut-off points. Oversampling for low income and maternal adversity allows greater generalisation to high-risk populations. Comprehensive range of confounders accounted for
	Britton (2007)[45]	Prospective cohort study	973 US women university medical centre, 422 completed pre-discharge survey, 265 completed 1 month survey (only BF mothers at time of hospital discharge were included)	STAI (state) administered at hospital discharge and 1 month PP	Any BF termination at 1 month (as defined by Labbok & Krasovec, 1990)	Women with higher state anxiety both pre-discharge and 1 month (measured either categorically or dimensionally) were more likely to have terminated any BF at 1 month	Multiple anxiety assessments. Comprehensive range of confounders accounted for. No depression measure taken

Table 2. Continued

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and any BF duration							
	Brown & Arnott (2014)[46]	Cross sectional survey (paper based and online	508 UK mothers with an infant aged between 0-12 months located in areas of varying deprivation to encourage a wide demographic group. At each feeding duration stage the sample was reduced in size to infants that age or older (n= 289 at 6 months)	4 item anxiety sub-scale of the Infancy Parenting Styles Questionnaire (IPSQ)	Self report question asking mothers duration of BF if they had stopped. Analysed as any BF (or no BF) at 2, 6, 12, and 26 weeks	Mothers who were still BF at 2 and 6 weeks had a reduction in anxiety when compared to those that FF or use EBM. No reduction found at 12 or 26 weeks.	Postpartum specific measure of anxiety, although only a subscale. No depression measure included. Multiple feeding outcome time-points. No definitions of BF provided. Comprehensive range of confounders accounted for.
	Buckner (1987) Doctoral Thesis[58]	Prospective cohort study	60 primiparous women who initiated BF from 2 urban US hospitals.	STAI (state) at 48-72 hrs post delivery	BF continuation at 2 and 4 weeks PP ascertained via follow up phone interview. Dichotomised for each time point (1= BF with no more than 4oz of formula and milk a day, 0 = >4oz food or formula)	State anxiety post-delivery was significantly lower among mothers continuing BF at 4 weeks PP when compared to those who choose to supplement more than 4oz per day. No difference found at 2 weeks PP	Imprecise definition of BF. No depression measure taken. Small sample size for analyses conducted. Comprehensive range of confounders accounted for. Did not compare demographics across anxiety, only feeding.
	Cooke et al. (2007)[59]	Prospective cohort study	365 Australian women from 3 public hospitals. 78% (n = 284) returned the 2- week survey, 73% (n = 268) returned the 6-week survey and 70% (n = 255) returned the 3-month survey.	STAI (state) 3 months PP	BF cessation (exclusive, predominant, partially, token grouped together) < 2 weeks, 2-6 weeks, >6 weeks to 3 months, >3 months. Breast feeding cessation was defined as 'Not breast feeding and do not plan to breast feed this baby in the future"	There were no difference in state anxiety levels at 3 months PP and time of any BF cessation (< 2 weeks, 2-6 weeks, >6 weeks to 3 months, >3 months)	Antenatal trait anxiety data also collected. EPDS data also collected. Bivariate analyses only. Clear description of response rate.
	Courtois et al. (2014)[38]	Prospective cohort study	247 mothers who initiated BF recruited from 1 Paris maternity hospital.	STAI at PP discharge	Self report BF continuation (EBF and partial grouped together) at 6 months PP.	Higher levels of state anxiety at discharge were associated with reduced odds of BF continuation at 6 months	Low anxiety levels overall in the sample. Sample size justified. Comprehensive range of confounders accounted for. Adequate retention rate. No depression measure taken. Imprecise definitions of BF
	Dusdieker et al. (1985)[57]	Cross sectional survey	145 primigravida women from 4 pediatric practice sites in Iowa, US. Diverse SES. Excluded women who initiated BF but discontinued early	Infant Feeding Questionnaire - various constructs ascertained via FA which related to postpartum anxiety - worries about health, BF worries, anxiety before BF, worries of lack of support.	BF duration at 6-8 weeks (defined as BF if <1 bottle of formula per day).	Specific postpartum breastfeeding worry is negatively associated with decision to continue predominant (<1 FF per day) BF for 6-8 weeks. Anxiety before breastfeeding (i.e. early non-specific anxiety may heighten BF convictions and reinforce specific concerns about BF.	Small sample size for analyses conducted. No indication of when the survey was completed postpartum - may contribute to recall bias. Postpartum specific measure of anxiety, although only subscales. Age, education and income controlled for. Imprecise definitions of BF. No depression measure taken.

Table 2. Continued

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and any BF duration							
	Hellin & Waller (1992)[50]	Prospective cohort study	145 UK women recruited from district hospital. 76 women completed measures at 1 week, 111 completed measures at 5 months. Only analysed those who BF their babies at least once (N=65)	STAI (state and trait) at 1 week and 5 months PP	Any BF continuation 2 months PP (divided by median split)	State and trait anxiety at 1 week PP but not 5 months PP was predictive of BF discontinuation at 2 months	Antenatal anxiety measurement also collected. Depression measure taken. Multiple anxiety assessments. No confounders accounted for in analysis
	Mezzacappa & Katkin (2002)[60]	Cross-sectional study	55 US mothers recruited for wider study examining maternal cognitions (28 BF/27 FF)	State Trait Personality Inventory (STPI) at any time between 1-12 months PP. Examined trait anxiety subscale	Feeding method (breast/bottle) between 1-12 months. BF defined as either EBF or with any amount of formula supplementation. FF defined as never BF or no BM at time of data collection but may have BF in the past	Trait anxiety in the first year postpartum does not differ between breast and bottle feeders	Anxiety subscale. No depression subscale used. Poor categorisation of BF/FF. Small sample size for multivariate analyses. Does not state if parametric assumptions met for analyses conducted. Some known confounders not controlled for.
	O'Brien et al. (2008)[53]	Prospective cohort study	657 eligible women from large regional centre in Queensland - inc 2 maternity units (1 private, 1 public). 375 returned questionnaires within 14 days PP (T1), 15% attrition rate between T1 and T2 (6 months PP)	Depression, Anxiety and Stress Scale 21 - DASS 21 (anxiety subscale) returned within 2 weeks PP	Any BF at 26 weeks PP ascertained via telephone interview	Anxiety in the first two weeks PP was not significantly associated with any BF at 26 weeks	Subscale used to measure PPA. Comprehensive range of confounders accounted for. Depression subscale also used. No comparison between responders or non-responders although attrition was low. Current Australian guidelines used to define BF.
	Papinczak & Turner (2000)[47]	Prospective cohort study	159 Australian mothers recruited from a group of 210 from a women's hospital in Brisbane. 30 controls randomly selected from this group were not interviewed at 3 months to measure the effect of interview or bias on BF outcomes, no difference between control and study group.	Duke Health Profile (anxiety subscale) self-report at 3 and 6 months PP	Any BF duration to 6 months (whether partial or exclusive)	Lower anxiety at 3 months PP was significantly associated with any BF at 6 months. Levels of anxiety at 6 months were not significantly associated with any BF at 6 months.	Imprecise definition of BF. Depression subscale also used. Comprehensive range of confounders accounted for. Small sample size had capacity to reduce power in multivariate analyses.
	Paul et al. (2013)[1]	Prospective cohort study	1154 US mothers taken from wider longitudinal study, 15 excluded because of twin delivery, 16 excluded because of missing EPDS/STAI data. Final sample of 1123. Mainly Caucasian, middle/high income.	STAI (state) administered via interview during hospital stay. A score > 40 served as a positive screen	BF duration assessed via telephone interview at 2 weeks, 2 months, and 6 months PP – measured using questions adapted from the Infant Feeding Practices study	A positive STAI score during the maternity stay was associated with reduced BF duration during the first 6 months after childbirth. Analyses stratified by parity show that a positive screen was significantly associated with reduced BF in primiparous but not multiparous women.	Only used women who intended to BF. Despite collecting data on exclusivity, this was not analysed. No definition of BF provided. Despite collecting data at multiple time points for STAI the analysis only used baseline screen. Comprehensive range of confounders accounted for. EPDS measure taken.

Table 2. Continued

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and any BF duration							
	Tinkle (1985) Doctoral Thesis[56]	Prospective cohort study	204 primiparous married women from 3 private hospitals in Texas, middle to upper income, 177 analysed (86% response rate)	STAI (state and trait) administered in the postpartum hospital stay	Successful BF at 4 months PP - determined by converting each subjects score on BF duration and satisfaction (ascertained via Infant Feeding Inventory mailed Qs) to z scores, summing and then median split	State anxiety was not a significant predictor of successful BF, however trait anxiety was negatively associated with successful BF group membership	Unusual definition of successful BF. Multicollinearity noted between predictors may have caused issue with analysis. No depression measure taken. Comprehensive range of confounders accounted for.
	Wiesenfeld et al. (1985)[61]	Cross sectional study	48 US mothers recruited via birth announcements, area pediatricians and word of mouth (24 breast/ 24 bottle)	Single 10 point Likert-scale question examining anxiety after 3 videotape stimuli of own infant (smiling, neutral, crying)	Feeding method - breast or bottle. No definition provided (Infants between 90-194 days)	Anxiety levels after viewing infant emotion videotapes did not differ between breast and bottle feeding mothers	Single, unvalidated question used to examine anxiety. No description of how BF was defined. Small sample size for analyses conducted - no indication of whether parametric assumptions were met. Only controlled for parity and age of infant
PPA and BF Attitudes							
	Britton (2007)[45]	Prospective cohort study	973 US women university medical centre, 422 completed pre-discharge survey, 265 completed 1 month survey (only BF mothers at time of hospital discharge were included)	STAI (state) administered at hopital discharge	Breastfeeding Confidence Scale (BCS) at hospital discharge	Pre-discharge state anxiety was negatively correlated with breastfeeding confidence	Bivariate analyses only. Validated exposure and outcome measures. No depression measure included.
	Dennis (2006)[62]	Cross sectional study	522 Canadian mothers. Predominately married and well educated. All initiated BF	STAI (state) at 1 week PP	Breastfeeding Self-Efficacy Scale (BSES) at 1 week PP	High state anxiety was negatively associated with breastfeeding self-efficacy at 1 week PP	Comprehensive range of confounders accounted for. Validated exposure and outcome measures. EPDS measure also used.
	Galler et al. (1999)[64]	Prospective cohort study	226 Barbadian mothers, low middle class from main maternity hospital. Follow ups: 158 (69%) at 7 weeks, 168 (74%) at 3 months, and 209 (92%) at 6 months.	Zung Anxiety Scales at 7 weeks	Preference for BF factor on feeding practices interview at 7 weeks PP, 3 months PP, and 6 months PP - items included number of BF/FF in last 24 hours, satisfaction after BF and quality of BF suck	Women with early anxiety had a lower preference for breastfeeding at 3 months PP	Depression measure also taken. Researcher developed feeding practices instrument. Range of environmental factors controlled for.
	Galler et al. (2006)[63]	Prospective cohort study	226 Barbadian mothers, low middle class from main maternity hospital. Follow ups: 158 (69%) at 7 weeks, 168 (74%) at 3 months, and 209 (92%) at 6 months.	Zung Anxiety Scales at 7 weeks	Feeding attitudes questionnaire at 7 weeks PP– researcher developed	Early anxiety was associated with some negative early feeding attitudes, namely the belief that BF is restrictive and should be private	Depression measure also taken. Researcher developed feeding attitudes instrument. Range of environmental factors controlled for

Table 2. Continued

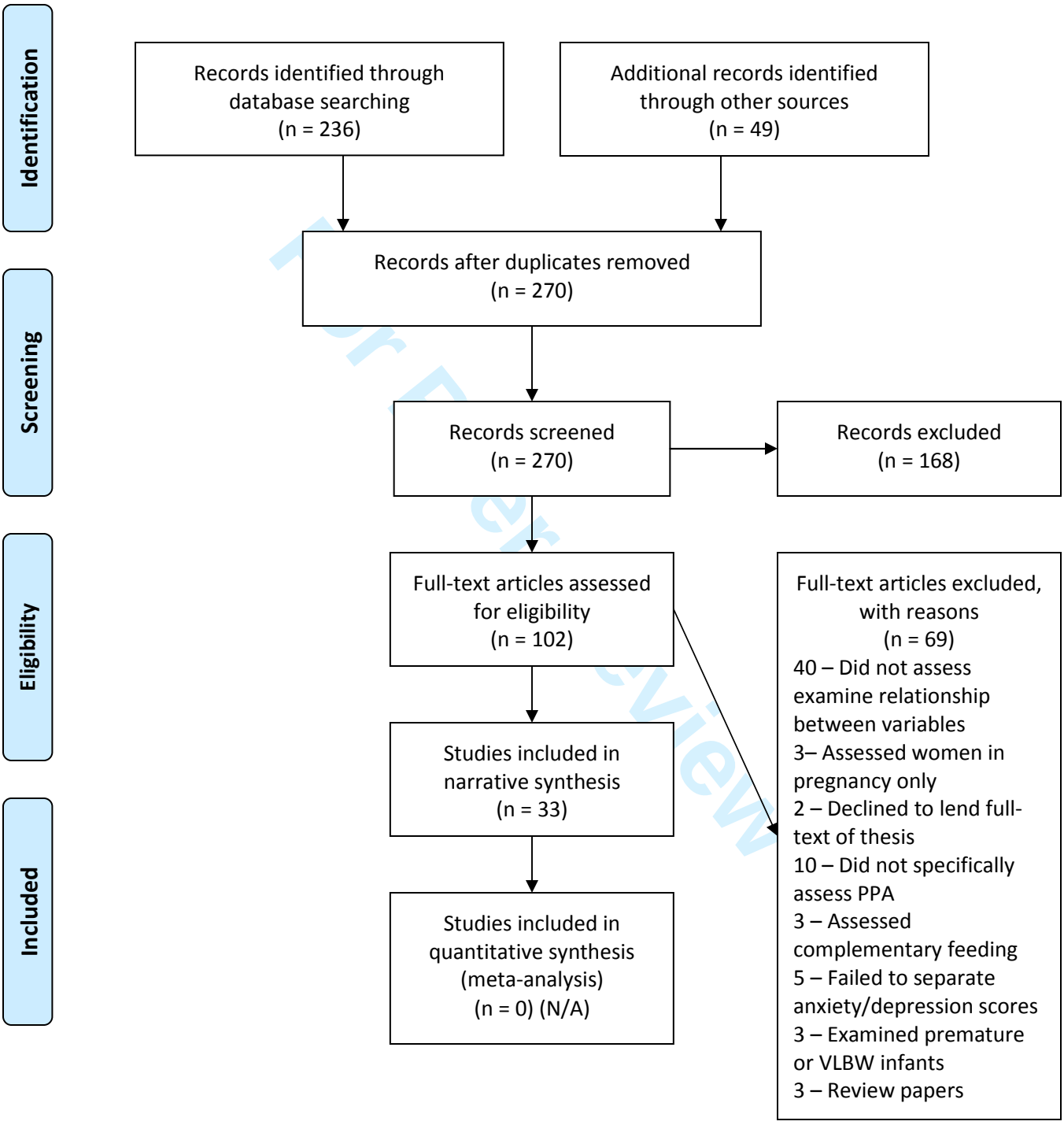
Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and Maternal/ Infant Feeding Behaviours							
	Aragaki (2002) MSc Thesis[39]	Prospective cohort study	168 BF mothers sampled from University hospital in Brazil. Split into primiparous and multiparous (42 primiparous normal lactation, 42 insufficient milk production).	STAI: state anxiety at 10 days PP and 30 days PP; trait anxiety at 10 days PP	Milk production - split into normal and abnormal. Ascertained via physical breast examination and mothers complaints of infant behaviour or BF problem.	No relationship between postpartum state or trait anxiety and milk production in the first month postpartum in primiparous or multiparous women.	100% follow up rate as part of nursing consultation. Unusual method of defining abnormal milk production. No confounders accounted for. No depression measure taken
	Blank (1986)[65]	Cross sectional study	65 US mother infant couples (59 Black) from Alabama university hospital. Only FF mothers included	STAI (state and trait) between 48-72 hours PP. State scale given pre-feed and during feed, trait given post feed	Infant satiety defined as pre-feed and post feed serum glucose levels, and amount of formula consumed	Formula consumption difference scores varied by in-feed state anxiety scores. Infants of slightly anxious mothers consumed more formula than those with extremely low anxiety.	Bivariate analyses only. Unable to conduct analyses on serum glucose levels due to high chance of Type 1 error. No depression measure taken.
	Richter & Reck (2013)[67]	Cross sectional survey	57 German women taken from wider longitudinal study. Recruited from psychiatry ward to gain sub sample of clinically anxious mothers (n=21, 36.8%)	STAI (state and trait) administered to mothers of infants aged between 2.5 and 4.3 months	Crying, Feeding and Sleeping Inventory for infant regulatory problems. Feeding subscale has 13 items about feeding difficulties	Higher levels of state and trait anxiety were associated with feeding difficulties between 2 and 5 months PP.	Feeding difficulties subscale only. No depression measure taken. Range of confounders accounted for.
	Hart et al. (2011)[66]	Cross sectional study	50 BF US women from university hospital. 196 recruited, high attrition mainly due to exclusion of those who had supplemented with formula in last 24 hours	STAI between 9-16 days (second week PP) at home visit	Latch quality (first 2 mins of feeding session, 3 point scale). Milk intake (subtracted prefeed from postfeed weights). Sensitive positioning (3 point scale). Frequency of touch (5 point scale). Frequency of vocalisation (5 point scale). Duration of feeding (in mins). All scales researcher developed.	STAI scores in BF mothers were positively associated with frequency of touch during a feeding session in the second week PP. No other associations.	Trained coders. Good inter-rater reliability. Depression measure also taken. Clear analyses with range of confounders accounted for. Small sample size may have lacked adequate power.
	Hellin & Waller (1992)[50]	Prospective cohort study	145 UK women recruited from district hospital. 76 women completed measures at 1 week, 111 completed measures at 5 months. Only analysed those who BF their babies at least once (N=65)	STAI (state and trait) at 1 week and 5 months PP	Feeding difficulties – researcher developed VAS scales. Physical problems with breastfeeding – researcher developed checklist. Both maternal self-report at 5 months PP	High state anxiety at 5 months was associated with infant reflux concerns. High trait anxiety at 1 week PP was associated with food fussiness. High trait anxiety scores at 5 months was associated with hungriness and demanding behaviour	Antenatal anxiety measurement also collected. Depression measure taken. Multiple anxiety assessments. No confounders accounted for in analysis

Table 2. Continued

Principal Outcome	Authors	Study Design	Sample	PPA Measure	Infant Feeding Outcome	Summary of Results	Methodological Comment
PPA and Breast Milk Composition							
	Hart et al. (2004)[68]	Cross sectional study	32 EBF US mothers recruited from university hospital. 150 recruited but only 40 EBF at 1 week PP. Only 32 eligible to schedule appt. Strict exclusion criteria to avoid breast milk confounds	STAI (state) and POMS (anxiety subscale) between 7-11 days PP	Cortisol and Secretory Immunoglobin (Sig A) assay levels in breast milk. Milk collection took place after 2 hours of not BF to control for diurnal variations	Anxiety levels in the first two weeks PP as assessed by two measures were not associated with cortisol or Sig A levels in breast milk in EBF women	Small sample size for parametric analyses. Range of confounders accounted for. Multiple measures of anxiety taken. Depression measures also taken. Interestingly, SigA was associated with depression.
	Kawano & Emori (2015)[69]	Cross sectional study	101 EBF Japanese mothers recruited from Tokyo urban hospital, 81 eligible to participate at 2 weeks PP. Strict exclusion criteria to avoid breast milk confounds	STAI (state and trait) and POMS (anxiety subscale) at 2 weeks PP	Breast milk Sig A assay levels in milk taken 2 weeks PP and immediately after BF	Moderate inverse correlations were found between early anxiety (as measured on three scales) and levels of SigA in BM in the early PP.	Clear justification of statistical analysis. Justified sample size when compared to other breast milk composition studies included. Only parity and age assessed as confounders. Depression measures taken and also significant.
	Ozbek et al. (2008)[70]	Prospective case-control study	64 EBF women from 1 urban Turkish hospital. 21 cases, 43 controls recruited over 3 years.	STAI (state and trait) before 10 days PP	Elevated breast milk sodium (BMS) (cases) or not (controls) examined using ion selective method. Medical and physiological measures used to ascertain hypernatraemic dehydration with associated elevated breast milk sodium in cases	Mothers with elevated BMS (cases) had significantly higher state anxiety scores compared with controls. No differences found for trait anxiety.	Depression measure also taken. Comprehensive range of demographics accounted for. Clear definition of cases and controls.
	Zanardo et al. (2001)[22]	Cross sectional study	42 EBF Italian women (14 of these delivered preterm infants and were excluded from the review). 14 vaginal delivery, 14 c-section (analysed separately). Strict exclusion criteria to avoid breast milk confounds.	STAI (state and trait) at 4 days PP	Colostral milk beta-endorphin concentrations (β assay levels extracted using RIA kit. Collected in the morning on day 4 PP after overnight bed rest	In mothers presenting increased colostral milk b-EP galactopoiesis, after vaginal delivery, there was a significant negative correlation between state and anxiety and colostral milk β-EP. No other associations present.	Bivariate analyses only. Small sample size for subgroup analyses. No depression measure taken.

PPA indicates Postpartum Anxiety; PP, Postpartum; BF, Breastfeeding, FF, Formula Feeding; EBF, Exclusively Breastfeeding; EFF, Exclusively Formula Feeding; EBM, Expressed Breast milk;

PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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